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HYDROGEN ENERGY IN SOLVING PROBLEMS OF SUPERCONDUCTIVITY

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ANNOTATION

In the article, the author described the important features of the phenomenon of superconductivity and its connection with hydrogen energy in some specific cases. In the article, some criteria for interrelation of hydrogen energy and superconductivity phenomenon of magnesium diboride superconducting cable as the constituents of a whole system are highlighted.

Keywords: *Superconductivity, hydrogen energy, hybrid energy transfer, $Mg\ B_2$ superconducting cable, liquefied natural gas, microwave plasma correction.*

Introduction. Here are some examples of the practical significance of the superconductivity phenomenon [1]:

► Uninterruptible power supply in the superconducting mode can provide a constant power supply. Success in this area is very important to meet the needs of the population. In order to carry out thermonuclear reactions, it is necessary to create a strong magnetic field. This can only be done from packaging made of superconducting materials.

► Wires and tapes made of several kilometers of superconductors are widely used in industry. Such wires and tapes have good efficiency.

► In the field of medicine, there are superconductors. As an example, we can say that the magnetic coils used in modern tomography are made of superconductors.

► High-speed computing devices in electronics, magnesium field detectors, radiation detectors, microwave communication devices are made of superconductors. In transport, superconductors drive Maglev trains. Such trains move on the railway using an electromagnetic field and do not touch the rails.

There are many examples of this, which increases the need of mankind for the physics of superconductivity. A pertinent question arises: is there a connection between hydrogen and superconductivity? [3, 5-6, 9-11]. First of all, it should be noted that the chemical element hydrogen is associated with the phenomenon of superconductivity in the formation of superconductivity in the production of liquid hydrogen. It is also used in the manufacture of high-pressure superconductors in substances containing hydrogen, such as hydrogen sulfide. In recent years, extensive research has been conducted on the hybrid transfer of hydrogen and electricity in superconducting cables (H_3S). All this suggests that hydrogen energy and superconductivity have many unknown connections, and that their study could lead to problems in both areas.

Methods. Pipeline infrastructure is one of the applications of superconductivity for the hydrogen economy. When liquid hydrogen is supplied from renewable sources, superconductivity is found to be more widely used. This can be done in car manufacturing. Several car models that use liquid hydrogen are already available. The car tank can contain up to 100 liters of liquid hydrogen, and using its lower temperature, the car can be equipped with superconducting devices. The car is compact and efficient may have an engine; superconducting generator to meet the electrical needs of the car; superconducting energy storage unit; lossless superconducting similar; superconducting current limiter that protects the car's electrical system; superconducting computer, etc. Some of the superconductors, such as the flexible flat MgB_2 superconducting cable, have already been developed. It is also possible to design superconducting power units for the construction of superconducting trains, aircraft, ships, submarines, spacecraft and houses. Appliances should have about 200-300 liters of liquid hydrogen and superconducting devices adapted for home use, as in a superconducting machine. The house will be self-sufficient for some time and will be immune to power outages. This will be of particular importance for hospitals and defense facilities. Superconductors can also be widely used in magnetic field screening. In particular, MgB_2 is attractive for space applications because it is lightly conductive and operates there in limited quantities or even without liquid hydrogen due to the low temperature in space. MgB_2 can be selected for these applications, especially on the Moon's surface or in Earth's orbit, where it also operates in an oxygen-free environment. MgB_2 $s$mall cylinders showing complete magnetic field screening have already been demonstrated. When liquid hydrogen is produced on a large scale, magnetic screening can spread to larger objects. In terms of materials, even a single superconducting tube could magnetically protect the entire planet. For example, the required amount of bar for the MgB_2 pipeline can be mined in 5 years for land. Other global projects, such as generating energy from solar wind or separating it from the subsurface in regions of magnetically active volcano, could also be undertaken [2].

Decentralized hydrogen economy-hydrogen cryomagnetics. Clearly, with the expected rising cost of helium, an alternative cryogen is required. Due to the risk of fire, neon is not suitable as a direct coolant and as a result of high costs. However, indirect hydrogen cooling of the closed helium cycle is a suitable solution, allowing the magnetic cooling to acquire helium resources that are constantly declining, and expected prices to rise. Considering all of the above reasons for the use of indirect cooling of liquid superconductors with liquid hydrogen in combination with a compressed closed helium gas cycle, let us consider a hospital-specific system common to the decentralized hydrogen economy. The link between hydrogen production, liquefaction, storage and use can be well established. In Figure 3.5, magnetic resonance imaging (MRI) from a renewable or zero-emitting source to a hydrogen atom in CO_2, an outdoor liquor and a helium-enclosed loop that provides indirect cooling through a permanent data center cable for uninterruptible power supply superconducting bearings of the flywheel energy storage system, which is transmitted through a closed loop of helium gas circulation (figure 1).

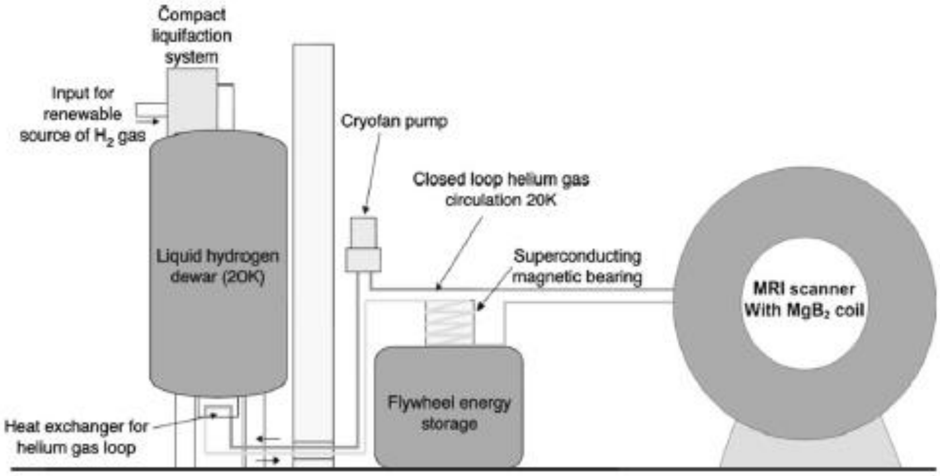

Figure 1. Infrastructure for the use of hydrogen and superconductors in hospitals.

Results. Decentralized scenario for the use of hydrogen in conjunction with a hospitable environment to meet future energy reserves, energy requirements and cryogenic requirements. The choice of hydrogen production is made by renewable and low-carbon emissions methods, as the world seeks to reduce carbon emissions to mitigate climate change. The importance of the hydrogen industry in the development of other industries can be determined by the production of carbon for the carbon industry as a product, the production of liquid hydrogen that provides 20 K for cryogenic applications that allow microwave plasma reforming and the superconducting industry. The use of liquefied natural gas as a method of natural gas transportation is used as a result of reduced costs and the increasing importance of liquefied natural gas (LNG) for transportation due to the ability to transport and store large volumes. The secondary use of natural liquefied gas in hydrogen liquefaction is described; however, this is only appropriate when hydrogen is diluted in place of the LNG plant. The traditional use of natural gas to generate electricity to supply the grid is also included. In this decentralized hydrogen scenario, compressed and liquefied hydrogen is produced from wind energy by electrolysis of water and natural gas using microwave plasma reactors (figure 2).

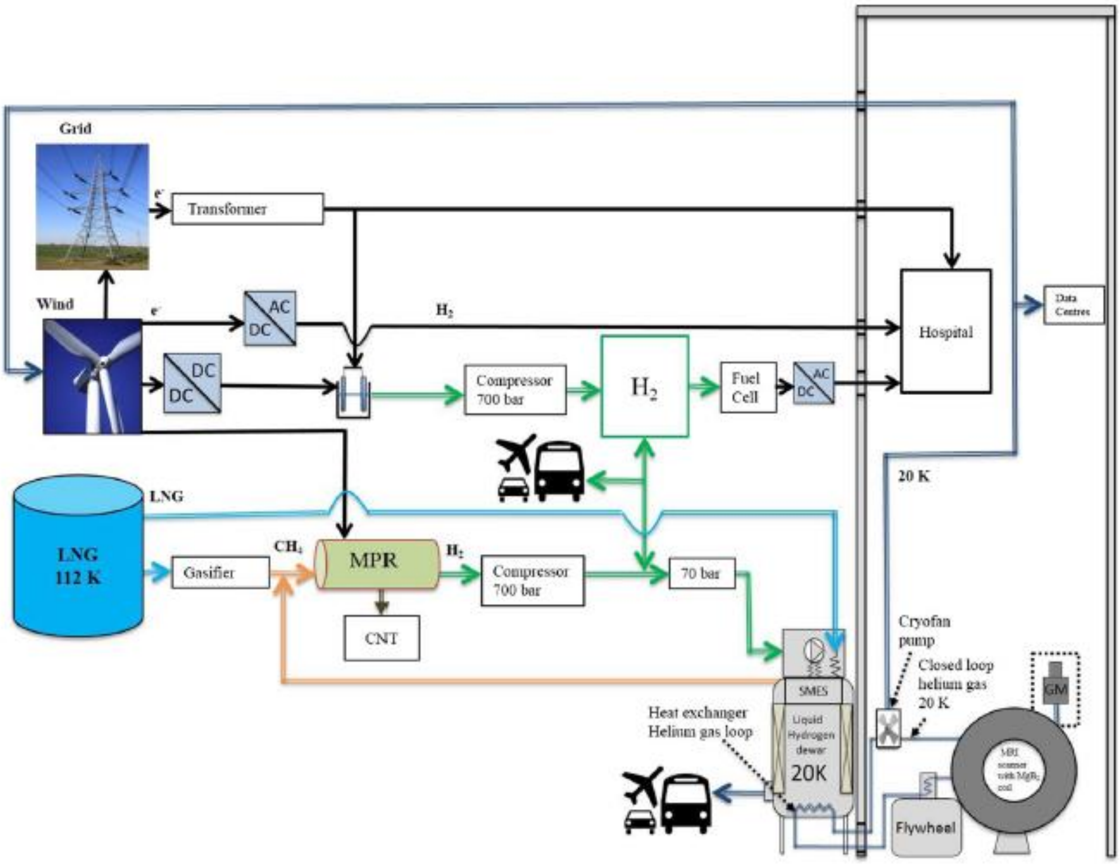

Figure 2. The decentralized production of hydrogen through zero CO_2 emission processes and the energy carrier, the energy storage medium, is used as the cooled cryogen. True superconducting devices for indirect contact with liquid hydrogen are superconducting magnetic energy storage, flywheel energy storage system, magnetic resonance imaging (MRI) and DC.

Discussion. The use of liquid hydrogen is a major focus, and hydrogen cryomagnetism is capable of creating a superconducting industry as it faces resource problems due to rising helium prices. From Figure 3.6, liquid hydrogen is also suitable for transportation applications for use in automobiles, e.g. BMW and buses and these vehicles use liquid hydrogen instead of compressed hydrogen. This reduced production of hydrogen can be used for domestic, transport and industrial purposes, it is cryogenic and can be used both as an energy carrier and as a cryogenic medium.

As the world strives for a low-carbon economy, hydrogen production from carbon-free technology is important. Microwave plasma reforming is a method of hydrogen production that produces hydrogen and valuable carbon nanoparticles. This means that the hydrogen industry can contribute to the growth of the carbon industry. From this process, two valuable products are produced. With the growth of the global wind industry, wind is another potential source of hydrogen production [4,7-8]. The wind industry is expected to reduce the world's fossil fuel consumption; however, with wind power outages, it is necessary to use energy reserves. Hydrogen can be produced and pressed when there is an excessive demand, and can be sold at a time when the price of electricity is high for profit. The superconducting industry is facing challenges in delivering a suitable and economical cryogenic environment. The use of liquid hydrogen allows the development of the superconducting industry.

After a successful study of the presence of helium from natural resources using system dynamics, a similar approach can be used to study the relationship between hydrogen and superconducting applications. The use of a professional system dynamics simulation program allows Vensim DSS to combine hydrogen production dynamics with wind energy and microwave plasma correction (MPR) in a decentralized system and simulate the results to determine the results. Based on the formula of the SD model of hydrogen production systems, wind energy is used to meet demand, as well as to supply excess energy to energy storage systems, as well as power supply. Electricity is used to meet any demand that cannot be met by renewable technologies and storage systems. Electrolysis of methane and microwave plasma reforming (MPR) is a potential source of liquid hydrogen. The dynamics of the system allows to simulate the system under analysis and change the results of different sources of wind energy, the demand and efficiency of technology and the need for liquid hydrogen. This approach allows testing of real systems to model and test how they respond, the instantaneous output of the model to the variable inputs can be tested in SyntheSim mode at the variable input. For the examample, Venice program was done. The use of system dynamics should give an idea of the amount of raw material required for a microwave plasma reactor and the energy required from wind energy to produce liquid hydrogen. The use of MRI in hospitals is very important and has great cooling requirements as a power, which is reduced due to a decrease in the temperature required for magnetization; however, a small change appears to be below 30 K, and therefore a cryogen with a boiling point below 30 K is suitable for magnetic cooling.

Conclusions. However, helium is the cryogen of choice for the MRI magnets and superconducting industries, but due to the increased cost and lack of supply, indirect cooling with hydrogen is suitable for cryogenic engine solution. The superconducting industry of the model is divided into MRI requirements, the use of liquid hydraulic permanent cooling wires and the use of homopolar wind generators. The use of liquid hydrogen in transportation is also accounted for by a portion of the liquid hydrogen produced for indirect use.

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